HYBRID LATTICE-BOLTZMANN SIMULATION OF CONVECTIVE FLOW IN A CHANNEL WITH EXTENDED SURFACES

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To my beloved parents and wife

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ABSTRACT

Laminar convective flow in a channel with extended surfaces mounted at the bottom wall is investigated by using two methods. First, by the usual double-population SRT lattice Boltzmann method (LBM) and second by a hybrid scheme in which the flow is solved by single population LBM and the thermal field by the finite-difference (FD) technique with considering an appropriate coupling among them. Here, the iterative method has been chosen in order to solve the discretized energy equation with finite-difference. The transient Reynolds number for the condition of this study was determined to be 600 and all simulations were conducted in the laminar range of Reynolds numbers. It is shown that for CFD problems in which the steady state solution is desired or for those with time consistency it is possible to save computation time of the simulation remarkably by employing the aforementioned hybrid scheme. For the case study of this work, the hybrid scheme resulted in reduction of 18 percent of total simulation time.

ABSTRAK

Aliran perolakan lamina di dalam saluran dengan permukaan lanjutan di dasar saluran dikaji dengan menggunakan dua kaedah. Pertama, dengan kaedah biasa iaitu double population SRT melalui kaedah Lattice Boltzmann (LBM) dan yang kedua adalah dengan menggunakan kaedah hibrid di mana medan aliran diselesaikan dengan menggunakan single-population LBM manakala medan haba diselesaikan dengan menggunakan teknik perbezaan terhingga (FD) dengan mempertimbangkan gandingan yang sesuai untuk mereka. Di sini, kaedah iteratif telah dipilih untuk menyelesaikan persamaan tenaga dengan menggunakan kaedah perbezaan terhingga. Nombor Reynolds sementara untuk keadaan kajian ini telah ditentukan pada 600 dan semua simulasi telah dijalankan di julat nombor Reynolds yang lamina. Ia menunjukkan bahawa untuk masalah CFD yang memerlukan penyelesaian keadaan tenang atau bagi mereka dengan memerlukan konsistensi masa, ia menunjukan penjimatkan masa pengiraan simulasi yang banyak dengan menggunakan skim hibrid tersebut. Bagi kajian kes ini, skim hibrid menghasilkan pengurangan 18 peratus daripada jumlah masa simulasi.